CALIFORNIA STATE
Mining Bureau,
S.F. FRANCISCO.

GEOLOGICAL SURVEY OF KENTUCKY.

JNO. R. PROCTER, DIRECTOR.

REPORT ON THE

GEOLOGY OF WHITLEY COUNTY,

AND A PART OF PULASKI.

WITH MAP AND ILLUSTRATIONS.

BY A. R. CRANDALL, ASSISTANT.

STEREOTYPED FOR THE SURVEY BY E. POLK JOHNSON, PUBLIC PRINTER, FRANKFORT.

1908

Court-House, Williamsburgh, Whitley County, Ky.

CALIFORNIA STATE
Mining Bureau,
SAN FRANCISCO.

GEOLOGICAL SURVEY OF KENTUCKY.

JNO. R. PROCTER, DIRECTOR.

REPORT ON THE

GEOLOGY OF WHITLEY COUNTY,

AND A PART OF PULASKI.

WITH MAP AND ILLUSTRATIONS.

BY A. R. CRANDALL, ASSISTANT.

STEREOTYPED FOR THE SURVEY BY E. POLK JOHNSON, PUBLIC PRINTER, FRANKFORT.

ERRATA.

Page 7, eighteenth line from top, for north-*west* read north-*east;* page 15, general section, "Place of Lilly Coal," omitted near top; and for Bryan read Bryvan, below; Plate-view *of* Jellico Mountain, etc., read View *from* Jellico Mountain, etc. Page 26, next to last line, period after Station, and read southward from Pine-Knot Station. This bed may be found, etc.

INTRODUCTORY LETTER.

J. R. PROCTER, *Director of the Kentucky Geological Survey:*

SIR: In continuance of the work of the Survey under your direction, I submit the accompanying report on the geology of Whitley county, and an adjacent part of Pulaski. In respect to this report, it is but just to state that many adverse circumstances have conspired to delay its completion, even on the basis of a preliminary report. As an offset to this, it will be found to be based on a more detailed study of some portions of this region, which, from the lack of readily recognized horizons, and also of exposures of economic beds, would otherwise have been less adequately, if not incorrectly, represented. In respect to this, it should be added that the equivalency of economic beds in different parts of this extensive field is still a matter of doubt in some localities; and the extension of these beds through areas in which they may be supposed to occur, as known elements of the general section, must of necessity be left to future developments; but the facts essential to an intelligent view of the possibilities of this region, will be found to be embodied in this report.

Very respectfully,

A. R. CRANDALL,

Assistant Kentucky Geological Survey.

REPORT ON THE GEOLOGY OF WHITLEY COUNTY, AND ON A PART OF PULASKI COUNTY.

Whitley county embraces a territory about 600 square miles in area; extending in irregular outline from the Tennessee line northward, across the valley of the Cumberland river, in its detour around the higher drainage plain of Knox and Laurel counties. It reaches along the State line from a point a few miles east of Pine Mountain, on the Clear Fork of the Cumberland river above the "Narrows," to the South Fork of the Cumberland, a distance of 34 miles.

The county was organized in 1818 from a part of Knox county, and Williamsburg, centrally located on the Cumberland river, and now a town of considerable business importance, was made the County-town.

GENERAL GEOLOGY, TOPOGRAPHY AND SOIL.

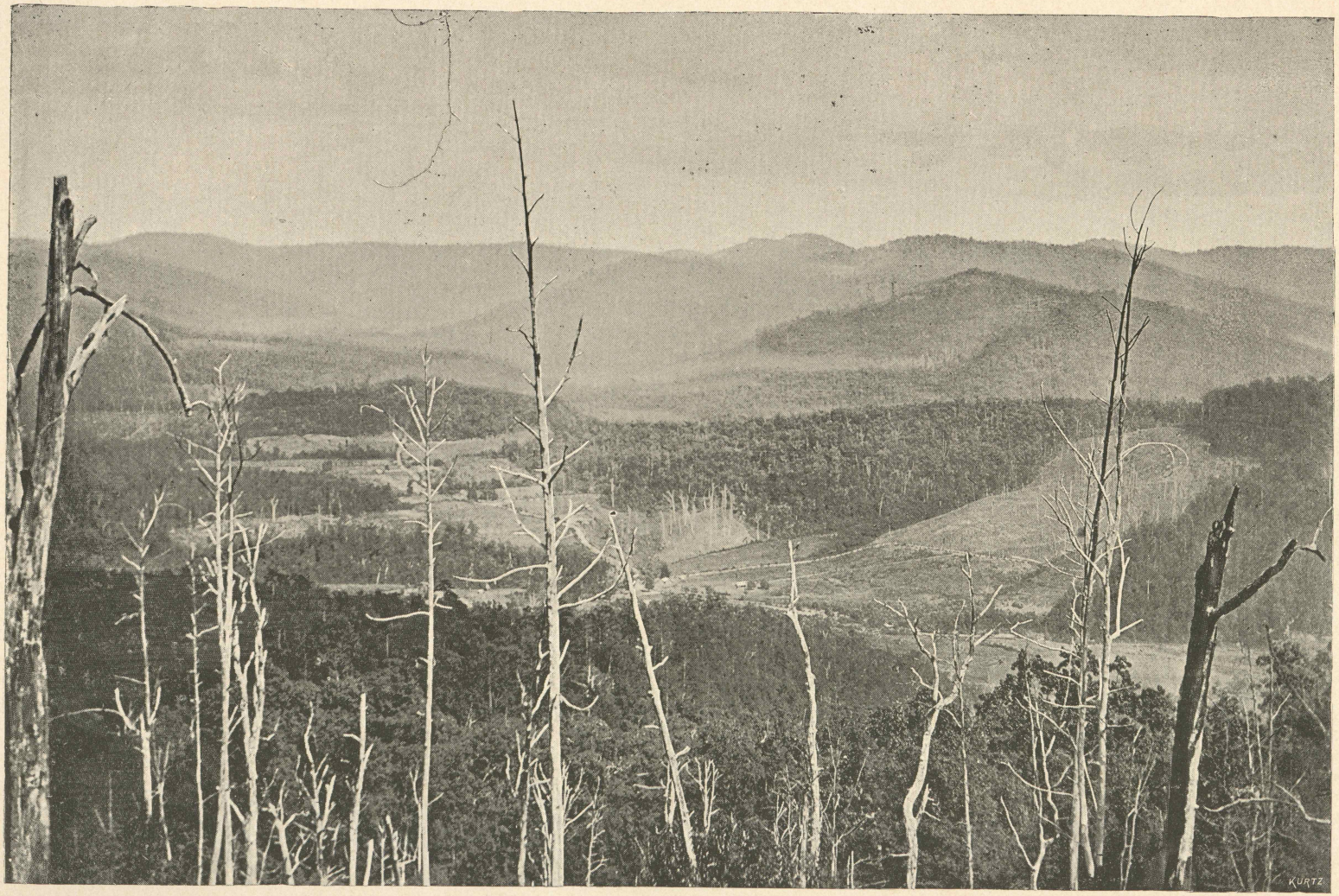
The topography of Whitley presents some interesting features which are traceable, with various modifications, along the border of the eastern coal field, from the Ohio river southward into Tennessee. This border is in general marked by prominent but broken escarpments, the receding outcrop of the Subcarboniferous limestone and of the Conglomerate sandrock of the coal measures, which rise above the eastward-dipping Devonian and Subcarboniferous shales, forming a distinct line of demarkation between the central blue-grass plains and the hill lands of Eastern Kentucky. To the southward, however, this line becomes less definite with the depression of the Silurian axis, and the attendant widening of the erosion plains on the outcrop of the several geological formations which rise above it to the eastward. The main drainage is across these formations westward, like that of the Kentucky

river valley. The tributary rivers and larger creeks, as also the Cumberland river itself, locally flow in valleys that conform somewhat to lines of outcrop, or to the strike of the rock formations. This is more noticeable in the western portion of the county, and in Pulaski, where the streams flow in the rocks near the base of the coal measures, than eastward, where the thickening of the series tends to reduce the dip to a slight inclination, and even to reverse it in some of the upper beds.

Like Elliott county, Whitley region has its two types of country. The north-western portion, known in part as the Flatwoods, has much in common with the Conglomerate tablelands of western Elliott, illustrating an advanced condition in the leveling stage of erosion, while the south-eastern part, like the eastern half of Elliott, illustrates with striking contrast the hill and valley stage. South of the Cumberland river, the hill region begins abruptly with the Jellico Mountain, which rises from the foot of the Flatwoods slope to a height of 1,000 to 1,200 feet. North of the river the Flatwoods topography extends eastward to the main Watts creek valley, gradually approaching in relief, the hills which form the east side of the valley. These hills are less than 600 feet high, but they fall in line with, and may, in a general way, be regarded as a continuation of the Jellico range.

While the general south-east dip of the rock beds gives to the country belts of successive geological formations, with striking contrasts in the topography of the region as a whole, the special features which are seen in traveling across these belts are so characteristic as to serve in a general way as an index of the geology of the several belts.

The rocks exposed in this field represent a part of the Devonian age and the greater part of the Carboniferous age. The divisions of the latter only are conspicuous in the topography of the region, the former being brought to the surface at the Pine Mountain fault, in a belt too narrow to give it any prominence in the surface features of that mountain. The Oriskany beds of the Upper Silurian underlie this formation, covered from view mostly by the horizontal coal measure rocks at the foot of the mountain. The Waverly group or knobstone



View of Jellico Mountain, rising from the border of Flatwoods, Whitley County, Ky.

formation of the Subcarboniferous division, like the Devonian black slate, has its outcrop beyond the limit of the field treated of in this report, but is exposed by the Pine Mountain fault, so covered by the soil and fragments from overlying ledges as to make its thickness, supposed to be about 150 feet, a matter of doubtful estimation.

The Subcarboniferous limestone, the mountain limestone of the older reports, extends into this field, bringing with it the characteristic rocky slopes, sinking creeks and red soil of that formation. Being at the base of the series in this region, it is prominent in the lowest drainage only on the north-western border. It falls below the Cumberland river below the mouth of the Laurel river, as represented in the accompanying map.

The rocks of this division represent the St. Louis and Chester groups. The former is conspicuous in the hard grey limestone of Point Burnside, Somerset and Mt. Vernon, having a thickness of 250 feet or more. This formation is less prominent to the north-west. Lesley, in his report on the western outcrop line of the eastern coal field of Kentucky, gives the thickness on Buck creek, in Pulaski county, at 250 feet, and at Mt. Vernon, at 182 feet. This thickness is decreased to 50 or 60 feet in Menefee county, and only isolated patches of limestone are found on the Ohio river in Greenup county, as noted in reports on these regions.

The Chester group is less conspicuous. It is represented by earthy buff limestone, alternating with greenish and reddish marly shales, having an aggregate thickness of 25 to 40 feet. These beds are for the most part covered along with the lower beds of the formation above, so that the thickness is not easily obtained This has led to some confusion in statements of the relation of the coals above to the top of the Subcarboniferous rocks. This formation is fully exposed in a cut at Happy Hollow Station, on the Cincinnati Southern Railway, and at the mouth of Rockcastle river.

The Pine Mountain exposures of the Subcarboniferous limestone is in an abrupt, partially covered ledge above the olive shales and fine-grained sandstone of the Waverly group. The estimated thickness is 300 feet or more. A prominent bench

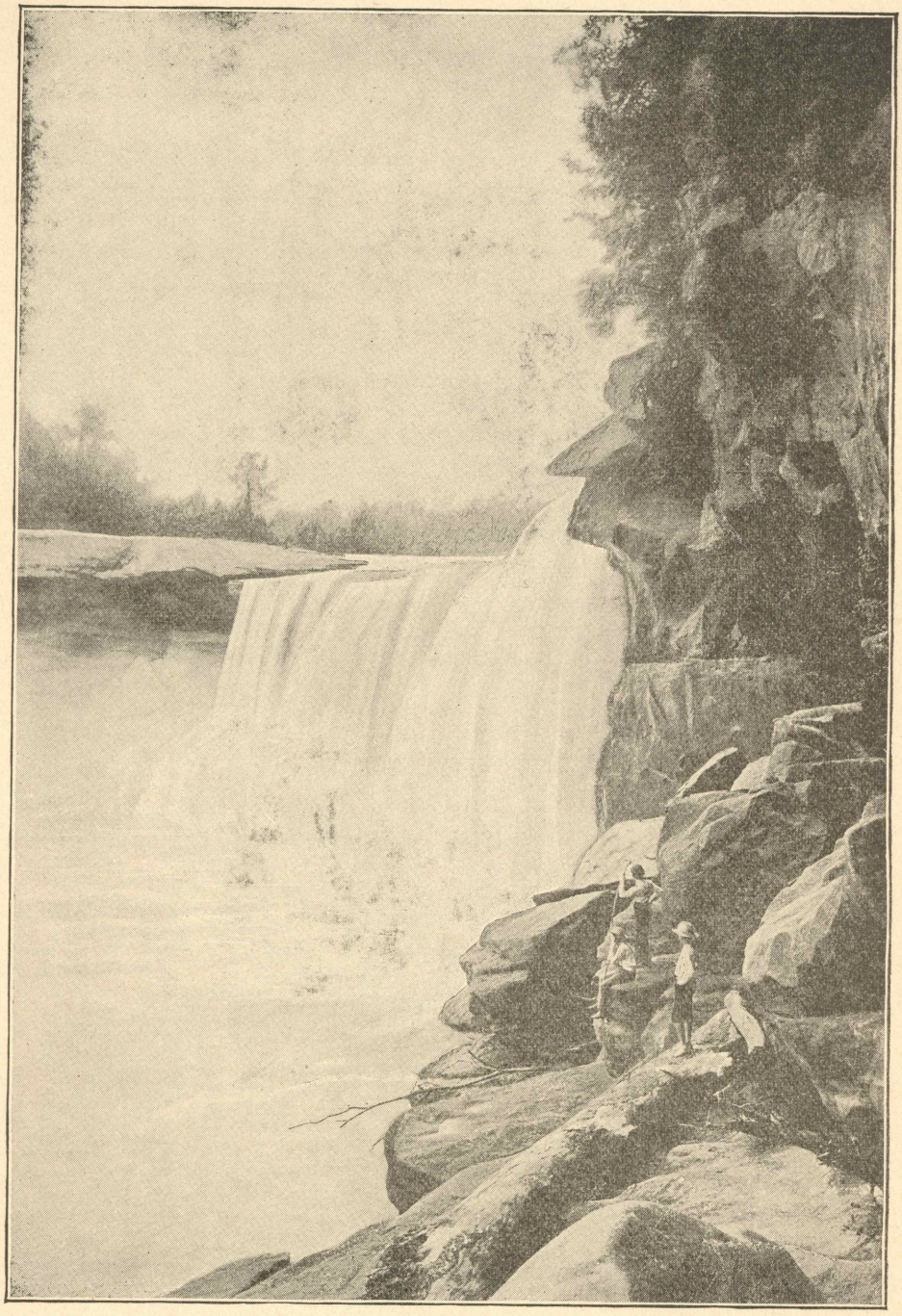
is formed by this limestone about half way up the mountain throughout its entire length.

The next formation above the Chester group is the Conglomerate division of the Carboniferous rocks, which forms the ridge traversed by the Cincinnati Southern Railway south of Happy Hollow Station, and which gives to the South Fork and the Rockcastle river valleys their striking natural features.

Respecting the limits of this formation, some confusion has heretofore prevailed which requires some notice.

This group of rocks, which varies in thickness from 10 feet in the hill back of Springville, on the Ohio river, to about 450 feet in the South Fork region, is made up in its south-western extension of alternating beds of shale, associated with coal seams, and of much more prominent coarse sand-rock ledges, some of which are conglomeratic with white quartz pebbles. The latter characteristic is more definite and persistent in the upper ledges, as also the shaly, coal-bearing beds are more prominent towards the base. For this reason Professor Lesley, in his report mentioned above, divides the formation into two members, the Conglomerate and the Sub-conglomerate, giving to the latter much the greater thickness. In a report on the Geology of Menefee county, the writer followed this classification so far as to call the Menefee coal a Sub-conglomerate seam, and the terms Sub-conglomerate and inter-conglomerate have, at various times, been used in the description of the coal beds of this formation, in the attempt to find designations suited to the facts as developed in different localities.

A more thorough acquaintance with the formation as exposed in various parts of Eastern Kentucky, and especially as found in the Pine and Cumberland Mountains, where the thickness exceeds 1,500 feet, and where the conglomerate character obtains so generally as to give the name to the whole series, leads to the conclusion that it would be more consistent with all the facts to regard the formation in all its phases as the Conglomerate division of the coal measures simply. Whether all the rocks included between the Chester group, as described, and the recognized top of the Conglomerate, as exposed in varying thickness at its western outcrop, constitute an equivalent representative of the Pine Mountain Conglom-



Cumberland Falls, Whitley Co.

erate may, perhaps, be questioned. The fact remains, however, that most, if not all of them, do represent that formation by position ; and while it is true that for a part of the series the name Conglomerate is far from descriptive, and may, without explanation, be misleading, this can hardly stand as a reason for retaining a descriptive classification which is misleading in the more important matter of place and equivalency in the general geological section. The whole assemblage of rocks in question will therefore be treated as the Conglomerate in division of the coal measures.

To avoid, in part, the repetition of a somewhat cumbersome name, and to have the advantage of an equivalent typical designation for the formation, as seen along the border of the coal-field, and as well illustrated in the Rockcastle river region, this assemblage of rocks will, in this report, sometimes be called the Rockcastle group, as also the greatly thickened equivalent formation in the Pine Mountain, will representatively be called the Pine Mountain group.

With this explanation, the description of the conglomerate formation of the region in question can readily be made to accord with Lesley's report, which relates to a portion of this field, and to regions adjoining in Rockcastle, Pulaski and Wayne counties.

The topography of the conglomerate formation is more characteristic than that of any other group in Eastern Kentucky. A partial illustration of this may be seen traveling by rail across this belt, as in the Sinking creek valley, on the Newport News and Mississippi Valley Railway ; from Hazle Patch to Altamont, on the Knoxville Branch of the Louisville & Nashville ; and from Sloan's Valley, southward on the Cincinnati Southern. The features, however, which may be observed from the car window are without special significance, except to those who have seen some of the towering walls which, like those on the Rockcastle river, and in a portion of the South Fork region, hem in the narrow drainage valleys with massive ledges and overhanging cliffs. In both of these regions, whether from above looking across or down into the walled valleys, or from the valleys looking up at the castellated hills, the scenic effects are unusually imposing. But, again,

the real wealth of scenery can be realized by those only who clamber about these laurel-fringed walls, seek out their unique water-worn recesses, the haunts of rare ferns, and who appreciatively note the picturesque carvings of time, in massive rock reliefs, and in the pictured record of the surface gravery.

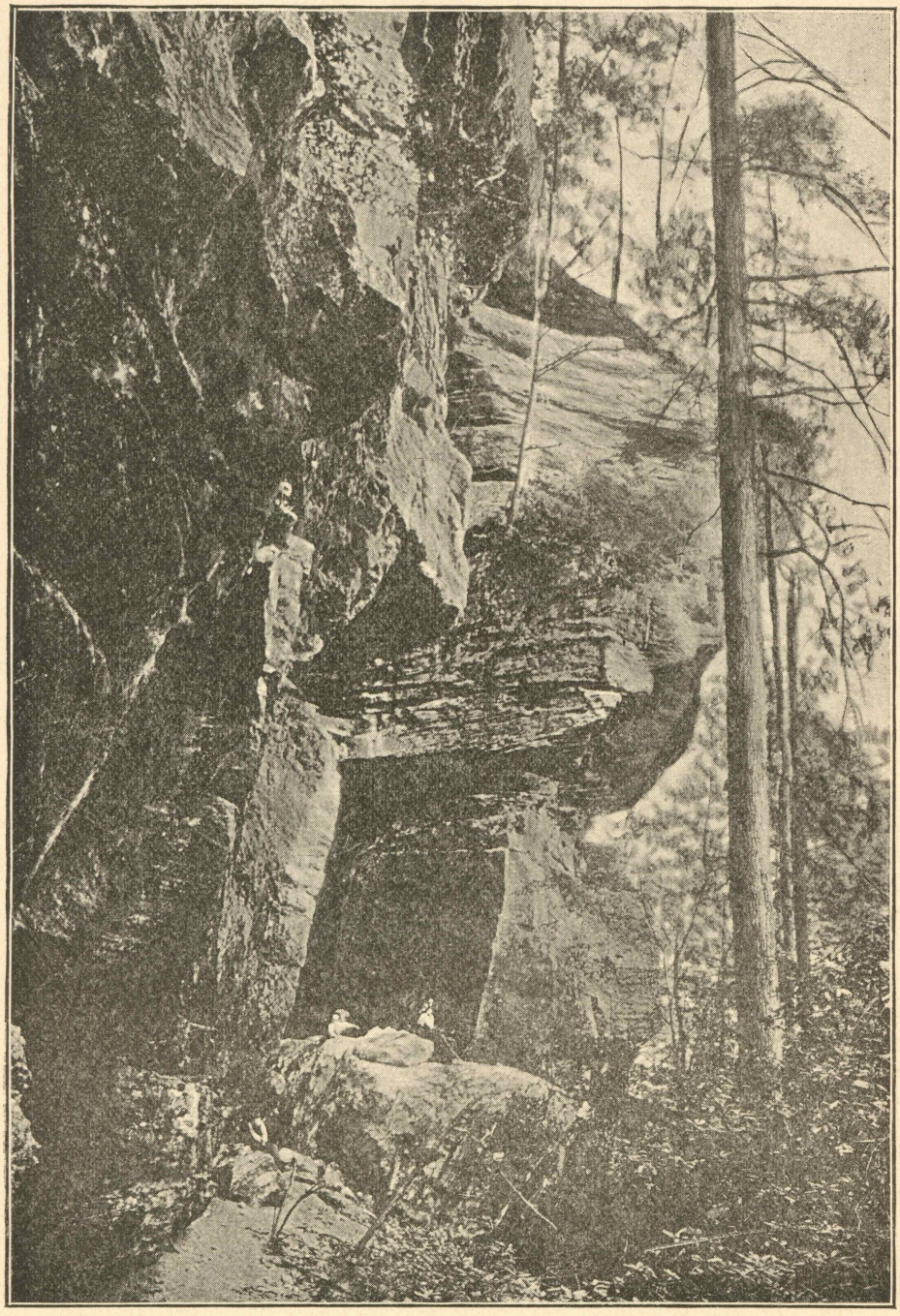
Attention is called to these features as giving to this belt an interest and a value which will be greatly increased in coming years. These romantic regions are admirable recreation grounds or natural parks. It will interest botanists to know that two of our more rare ferns, the climbing fern (Lygodium palmatum) and the moss fern (Trichomanes radicans) are found in some parts of this belt, both in considerable abundance.

The great Rockhouse and natural bridge and the Gulf, two or three miles west of Cumberland Falls Station, illustrate some of the striking results of the erosion of this massive formation, and among the many interesting special features in the Rockcastle region, the great Horse-shoe Rockhouse, on a branch of Bear creek, is especially noteworthy.

South-eastward the Conglomerate cliffs decrease in height, as seen on the Laurel river and on Marsh creek, and the continued dip carries the Rockcastle group below the drainage of the south-eastern half of the Flatwoods region. The low hills of this belt are made up of the shales and sand-rock of the coal measures above the conglomerate division.

In the Conglomerate belt, the farm land is on the table-land areas between the abrupt drainage valleys. The soil is sandy, but is not lacking in retentive clay. Under ordinary cultivation it is only moderately productive after the vegetable humus of the newly-cleared land has been exhausted. A considerable portion of this belt is still valuable forest land.

The Pine Mountain uplift presents the conglomerate formation in greatly increased thickness. It gives to this mountain its rugged features. The whole group is exposed in the Narrows, the Clear Fork water-gap in this fault scarp, at the State line. The estimated thickness by barometric observation exceeds 1,000 feet—more than twice the thickness of the equivalent Rockcastle group, 25 miles to the westward. The Pine Mountain group includes beds of shale and of shaly sandstone, at intervals of 100 to 200 feet between the Conglomerate benches.



Rock House ("Falcon's Retreat"), Rockcastle Springs, Pulaski Co.

The lower massive member of this group, instead of being conglomeratic, is largely made up of a hard quartzose like sandrock, which breaks up into irregular angular fragments, that are scattered over the steep slope above the limestone bench, adding to the difficulty of reaching the top of the mountain.

It will be noticed by those who visit this gorge, that the St. Louis group is exposed at the river level at the lower entrance of the Narrows. This is in consequence of the greater erosion at this place, producing an eastward deflection in the face of the mountain, and exposing the limestone along its dip from the limestone bench to the bed of the river. Here the Devonian black slate and the Waverly group are covered along the river bottom. Going up the gorge of the Narrows, the dip decreases from about 20 to 5 degrees, and the "Bee-rock," the upper member which is so prominent in the topography of the rock-terraced south eastern slope, falls to the drainage level near the mouth of Hickory creek, giving place again in the topography to the coal measure rocks above.

The disturbed condition of the rocks in some parts of the gorge indicates a break without any considerable vertical displacement, traversing the mountain axis, and facilitating the cutting out of this drainage gap. A careful study of this region, with reference to this and other geological problems, has not been made. This water gap offers a practicable way for a railway line through the Pine Mountain barrier, the Pineville gap and the Breaks of the Russell Fork of the Big Sandy river being the only other water gaps in the entire length of this mountain.

The coal measures above the Conglomerate division include in this field rocks to the thickness of about 1,500 feet. Until a more complete study has been made of this series, as found in the Eastern Kentucky coal-field at large, no attempt will be made to conform to the classification in neighboring States, or to compare with the general section of regions outside of Kentucky. It is apparent that there are no very good reasons for following the division into Lower, Barren and Upper measures, except in the fact that the rocks of a part of the Appalachian coal-field has been so classified. For the present, all of the coal measure rocks above the Conglomerate measures will be considered as an undivided series.

CALIFORNIA STATE

The topography of the hill region is not so specially characteristic of the formation out of which it is carved, as is that of the belts already considered. Alternating shales and sandstone give to the hills a benched slope, and to the valleys a terraced appearance; and at various levels, more especially towards the top of the series, masses of coarse sand-rock mark geological horizons with far-reaching exposures of bare ledges and projecting cliffs. These hard sand-rocks usually cap the ridges, spurs and low hills, at heights according with the progress of erosion, or with the general features of the drainage basins.

The soil of the hill region is derived from rocks more varied in character than those of the other belts. It is richer in vegetable mould in proportion as the timber growth is heavier or is left to protect the steeper slopes. Some of these slopes, when cleared, continue even surprisingly productive for a considerable time, the soil being loose enough to absorb the heavy rains and to prevent rapid washing. With continued plowing, however, these conditions are lost, and the soil becomes more clayey and heavy, a result that might be largely avoided by suiting the farming to the nature of the ground. The statement made for other regions holds good here, however, that a large portion of the hill country should be judiciously kept in forest, as a direct economic measure; to prevent the washing of the steeper hillsides, and to check the tendency to sudden disastrous floods. Agriculture can find suitable conditions for profitable prosecution in all the country covered by this report, but to be most successful, it must be by an intelligent adaptation to the conditions which go with the geology, and the resulting topography of the district. Both the Flatwoods and the hill region promise well for fruit-growing. The well-known Berry Red apple was originated in Whitley county. Many evidences of adaptation to small fruits have been noted, which are probably as much owing to surface features and to elevation, as to the character of the soil.

The accompanying map shows the distribution of the geological divisions which fall within the province of this report, as also the general elevations, the drainage and the prominent

features in the topography, especially of the south-eastern or hill region. Views to illustrate some of these features will, it is hoped, aid in giving significance to the map delineations and to the foregoing brief descriptions.

The timber growth of the two regions is unlike in many respects. The hills of the eastern region have a greater number of useful species and a larger growth. Among the soft wood timbers the following have been noted in the field covered by this report. The data is not at hand for detailed account of the distribution of species:

Yellow Poplar, Tulip Tree (Liriodendron tulipifera).
Cucumber Tree (Magnolia acuminata).
Umbrella Tree (Magnolia umbrella).
Ohio Buckeye (Æsculus glabra).
Chinquapin (Castanea pumilla).
Chestnut (Castanea vesca).
White Walnut (Juglans cinerea).
Black Walnut (Juglans nigra. L.)
River Birch (Betula nigra. Ait.)
Willow (several species).
White Elm (Ulmus Americana).
Sour-wood (Oxydendrum arboreum. D. C.)
Yellow Pine (Pinus mitis).
Scrub Pine (Pinus inops).
Spruce Pine or Hemlock (Abies Canadensis).
Sweet Gum (Liquidamber styraciflua). Bottom lands.
Sassafras (Sassafras officinale).

Of hard wood trees the following are found:

White Oak (Quercus alba).
Swamp Chestnut Oak (Q. prinus. Willd).
Mountain Chestnut Oak or Tan-bark Oak (Q. prinus, var. monticola).
Post Oak (Q. obtusilaba).
Red Oak (Q. rubra).
Black Oak (Q. tinctoria).
Spanish Oak (Q. falcata).

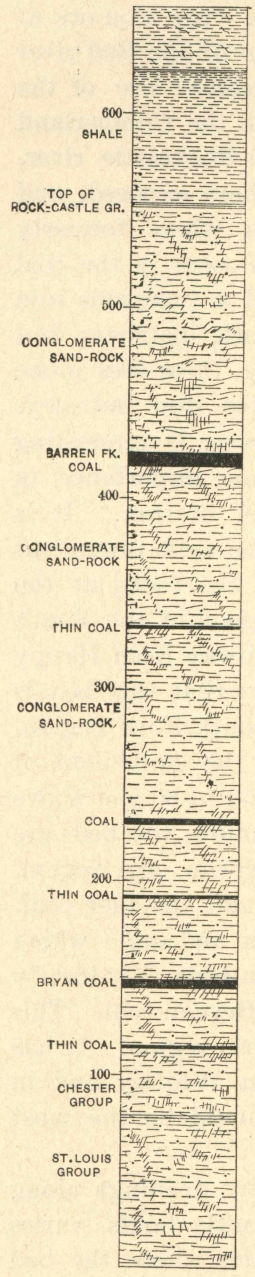
Scarlet Oak (Q. coccinea).
Willow Oak (Q. phellos). Moist low lands.
Laurel Oak (Q. imbricaria.)
Black-jack Oak (Q. nigra). Noticed in South Fork region only.
Pignut Hickory (Carya glabra. Torrey).
Shell-bark Hickory (C. sulcata).
Beech (Fagus ferruginea).
Sugar Maple (Acer sacharinum).
White Maple (A. dasycarpum).
Red Maple (A. rubra).
Ash Maple, Box Elder (Negundo aceroides).
Black Birch (Betula lenta).
Mulberry (Morus rubra).
Hornbeam (Carpinus Americana).
Ironwood (Ostrya Virginica).
Locust (Robina pseudacacia).
Yellow Wood (Cladrastis). Hill land, Patterson creek.
White Ash (Fraxinus Americana).
Sycamore (Platanus occidentalis).
Black Gum (Nyssa multiflora).

Many smaller trees and shrubs abound, some of which, like the flowering Dogwood (Cornus florida), the Service Berry (Amelanchier Canadensis), the great leaved Magnolias (M. umbrella and M. macrophylla) the Holly (Ilex opaca), the Red-bud (Cercis Canadensis), the wild Camelia (Stuartia Virginica), the Kalmias, the Rhododendrons, and many others, contribute in their turn so much of beauty to the woodland landscape, that it is at the least a pleasure to know that they have no special commercial value to make them a prey to the timberman's ax.

Adjacent to the larger streams, the yellow poplar has been mostly removed. The tan-bark oak has been mostly cut down near the railway lines for the bark alone. The black walnut trees of the original forest have very nearly all been removed. Fortunately for the future wealth of Whitley county, as also of Pulaski adjoining, much of her woodland has been so inaccessible as prevent an immediate exhauston of timber resources. Properly husbanded, the timber should be second in value to the coal deposits only, in a considerable portion of this region.

COAL, IRON ORES, CLAYS, ETC.

The coal-beds of this region are distributed through the two divisions of the coal measures at varying intervals. For each division alike, it may be said in a general way that there is a coal seam for each 100 feet of vertical section. The workable beds would be considerably less from the number of thin seams, and from the occasional thinning out of the workable beds. With all its forbidding appearances, the Conglomerate measures come nearer to this ratio than the measures above, or, in other words, in the percentage of carbonaceous matter deposited in workable beds of coal, the Rockcastle group is the richer division of the two. In the matter of economic value, much depends on the special qualities of the coal and on accessibility. In these respects, the upper division is of first importance. This field, as a whole, including the two divisions, from the range in quality and the great body of the deposits, is one of the most important in the Appalachian coal-fields.



CONGLOMERATE MEASURES.

The coal seams of the Rockcastle group as will be gathered from the brief general description of the formation, are more prominent towards the base of the vertical section. The accompanying generalized section, shows the typical order of beds for this group. In some portions of this Conglomerate field, all the features of this section, except the coarse cliff forming sand-rocks and conglomerates, are so generally covered, and the coals have been opened in so few places, that the extension of beds is a

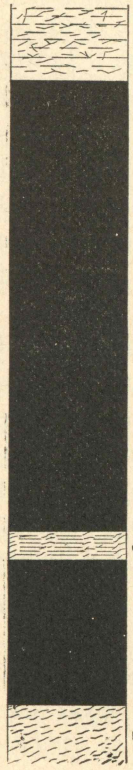
matter of inference. The order here indicated is, however, substantially correct, both as a basis for the description of coal beds, and as a guide to a fuller development. The iron ore at the top of the Chester group is the equivalent of the Red river ore of Estill county, and of the lower limestone ore of the Hanging Rock iron district. It is present in the Cumberland river region, at and below the mouth of the Rockcastle river, showing a foot in thickness at one point where exposed, and apparently considerably thicker in places where formerly opened. This ore and the Kidney ore, which occur in the coal measures above, have been made the basis of a profitable iron industry in the Red river and Hanging Rock districts; but with the recent developments in iron making, these ores alone can hardly serve as the basis of a profitable iron industry. The thin coal near the top of the Chester group is interesting as occurring at a coal level of some economic importance in Jackson county—the Jackson county cannel horizon. It is shown in the Happy Hollow region under the first prominent sandstone ledge. The variable character of the rocks at the base of the Rockcastle group, and a comparison of the South Fork section with the exposures along the railway from Happy Hollow to Greenwood, suggest the possibility that this bed is also the equivalent of Bryvan coal of the South Fork region, though that seam is generally regarded as the equivalent of the next bed above the Happy Hollow coal, 50 to 60 feet above the top of the Chester group. At Happy Hollow, the beds are as shown in the general section. In the Bryvan coal region, the thin coal seam is wanting apparently, and the first coal, 30 to 50 feet from the calcareous sand-rock and shale which represent the Chester group, or are transition beds that locally intervene between the two formations, is the Bryvan coal. This is the most prominent bed in the South Fork region. It has been opened at a number of places both in Whitley and in Pulaski, and rising to the westward, it should be the most widely distributed bed in Wayne county.

The thickness of this coal, as indicated by openings along the South Fork, on the Bryant and Vanwinkle lands, varies from 46 to 63 inches in one body. The points where the bed was exposed to view when this region was visited are mostly

in Whitley county. Near the "Devil's Jumps," some miles above the mouth of Roaring creek, the thickness of the main portion of the bed is 46 to 51 inches; at the mouth of this creek, 57 inches; on Worley branch, 55 to 63 inches; near the mouth of Rock creek, in Wayne county, 56 inches. In the point of the ridge, between Nigger and Big creek, this bed is in two benches, 31 and 23 inches, separated by 9 inches of shale. The lower 23 inches is a splint coal.

Preliminary tests of the coking quality of the Worley branch coal resulted favorably, as will be seen by the analysis of the coke, which is described by Dr. Peter as a firm and compact coke. The favorable result of these tests is the more interesting, as this bed is supposed to be the equivalent of the Pocahontas coal of Virginia.

In the following cut the shale parting should have been 10 inches instead of about 4, as drawn by the engraver.



Bryvan Coal, Worley Br.

An average of three analyses made from samples collected at different times by Capt. Crozer, Assistant Thruston, and myself, is added; and also the result of the analysis of coke made from this coal under the direction of Mr. Thruston:

Moisture	3.00	2.10
Volatile combustible matters	35.74	. . . .
Fixed carbon in coke	56.41	90.46
Ash	5.13	7.44
Sulphur	.797	.665

Further up the South Fork this coal shows a larger per cent. of volatile combustible matters. Samples from near the Devil's Jumps, collected by Mr. Thruston, give the following results:

Moisture	.90	1.50
Volatile combustible matters	39.86	39.40
Fixed carbon in coke	47.30	53.88
Ash	11.90	5.40
Percentage of sulphur	3.741	1.089

A gas coal of considerable richness is

indicated by these samples. The percentage of sulphur in one of these samples may be incidental, as is indicated by the other.

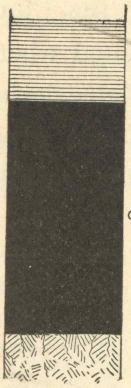
The Happy Hollow coal on the Cincinnati Southern Railway, 50 to 60 feet above the top of the Chester group, has 39 inches of good marketable coal, with surroundings as shown in the annexed cut. Sample for analysis was taken from a room on the main entry 500 feet from the entrance.

Happy Hollow Coal.

Moisture	1.40
Volatile combustible matters	36.20
Carbon in the coke	56.80
Ash	5.80
Sulphur	1.043

The entries here are about 50 feet above the grade of the C. S. Railway at Happy Hollow station.

In the Cumberland and Rockcastle river region, this seam is represented by the "Lower Coal" of the "Cumberland Coal" region. This was a noted field until the uncertain river transportation made it unprofitable to compete with other sources of supply for Nashville and other towns in the valley of the Cumberland. The lower coal is about 60 feet above the Chester shales, as noted at the Edwards mines, three-fourths of a mile below the mouth of the Rockcastle river. The Boyer, the McKee and the Hudson mines are at this level. The latter showed a thickness of four feet in shaly rock, with conglomerate sand-rock both above and below, as observed by Capt. W. C. Crozer. The Edwards coal, which is still mined, has been taken as a representative of this bed, though thinner than at the other mines. From a partial outcrop exposure of the McKee Big Lick seam, showing a splint coal 32 inches thick, with 4 inches



Edwards Coal.

of impure cannel resting on top, a sample was also taken for analysis.

	Edwards Coal.	Big Lick Coal.
Moisture	3.40	2.80
Volatile combustible matter	34.40	33.80
Carbon in coke	57.20	53.60
Ash	5.00	9.80
Sulphur	.687	2.58

Lesley reports having measured the McKee coal on this creek, now fallen in, giving 4 feet 9 inches of coal, with a slight clay parting, which at one point increases to 30 inches, with the coal 4 feet 6 inches thick. (See volume IV., Old Series, page 485.) The stain of this coal seam shows at various points up the Rockcastle river, following to the drainage above Rockcastle Springs. This bed also falls below the Cumberland river near the mouth of Laurel Fork.

The next workable coal in the series is also found in both the South Fork and the Rockcastle region. It is from 70 to 90 feet above the seam just described. This bed is opened on the Worley and Stover branches of the South Fork, 44 and 37 inches respectively, as measured by Mr. Thruston. The former has four inches of splint coal at the top. The latter only has been seen by the writer. It has the appearance of being a good coal. Samples for analysis were not obtained from this bed in this region. Probably the Wilson coal, faced up to show 30 inches on Little Indian creek, represents this bed; and the Dicks coal, reported by Lesley, in Wayne county (volume IV., Old Series), also visited by the writer, and found at one point, where reopened, to be 39 inches, including 3 inches of clay at the middle of the bed, is also at this level. A thin coal is found about half way between this and the main lower coal.

In the Cumberland and Rockcastle region, this bed is the main coal. This seam has been opened for mining, and more recently to show its extension in this region, at a number of points from which the following data respecting it is obtained.

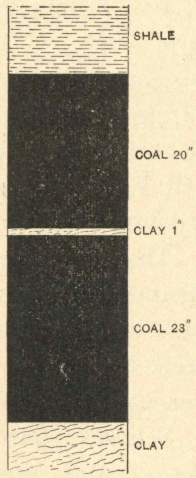
Rayburn's "Slip-up" mine, on the great bend of the Cumberland river, is the only place visited where mining is now carried on in this district at this coal horizon. The subjoined cut gives the bed section as shown in an entry recently driven.

Slipup Coal.

Moisture	2.00
Volatile combustible matter	34.80
Fixed carbon	55.20
Ash	8.00
Sulphur	1.20

This is about the average thickness as found in a number of entries in this locality.

Near the head of Addison branch this coal is opened, showing a maximum of 54 inches. A sample taken from the whole thickness of the bed gives the following results by chemical analysis.

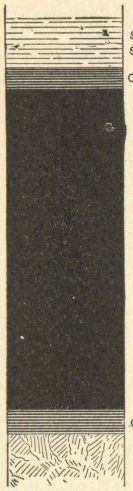


Addison Br. Coal.

Moisture	2.40
Volatile combustible matter	35.60
Fixed carbon	54.40
Ash	7.60
Sulphur	1.700

An opening on the head of Bear creek exposes 42 inches without parting. There is also a natural exposure of this bed in the

great crescent rock-house at the head of another branch of this creek. The analysis was made from a sample from the opening at the head of the creek.



Bear Cr. Coal.

Moisture	2.40
Volatile combustible matter	34.00
Fixed carbon	54.20
Ash	9.40
Sulphur	.467

This bed is opened on the waters of Buck creek, showing bed sections similar to the preceding. It is also reported by Lesley, on the waters of Pitman's creek, in workable thickness. Eastward in Laurel county, on Craig's creek, above the old salt well at Vox post-office, 51 inches is shown without parting. Sample for analysis was collected from this bed by Assistant G. M. Sullivan. The following is the report of Dr. Peter:

Moisture	1.70
Volatile combustible matter	33.50
Fixed carbon	57.20
Ash	7.60
Sulphur	1.785

An opening was formerly made one mile above Sublimity, or nearly four miles above Rockcastle Springs, by Montrose Graham, who reports 48 inches of coal, the upper 18 inches splint coal. The excavation had been entirely covered by a slip when recently visited. A massive sand-rock overlies this bed in the Rockcastle region, with a few feet of slate intervening. In the South Fork region, the place of this bed is not so conspicuously marked, the overlying sand-rock rarely forming cliff ledges. A thin coal is found at many places 25 to 30 feet below this coal bed. It is not known at any place to be a prominent bed.

The third workable coal seam of this group is the Barren Fork, Flat Rock, Greenwood, Beaver creek seam, about 200 feet higher up in the formation. Samples for analysis from

this bed were mostly collected by Assistant R. C. B. Thruston. Analyses of three samples taken in different ways are here given.

Barren Fk. Coal.

	Whole face . .	Run of mine. .	Nut coal. . . .
Moisture	1.54	2.32	2.12
Volatile combustible matter	33.80	32.48	31.56
Fixed carbon	58.26	59.10	59.02
Ash	6.40	6.10	7.30
Sulphur	1.54	1.079	1.878

Samples collected by the writer from near the outcrop, before the mine was put in operation, gave results very nearly the same.

The Flat Rock coal differs somewhat from the Barren Fork in its bed section, but it is essentially the same in character. The analysis is of sample from the whole thickness of the bed.

Flat Rock Coal.

Moisture	1.76
Volatile combustible matter	36.24
Fixed carbon	55.26
Ash	6.74
Sulphur	1.286

As mined at these points, this bed is from 150 to 180 feet below the grade of the Cincinnati Southern Railroad.

The result of the analysis of the Greenwood coal is as follows:

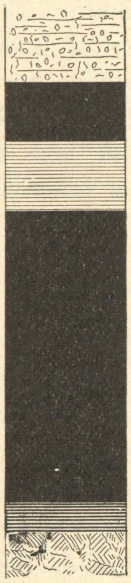
Moisture	2 50
Volatile combustible matter	36.20
Fixed carbon	52 10
Ash	5.80
Sulphur	2.601

The composition of the Beaver creek coal, as indicated by two analyses, is here given:

Entry No. 6, Beaver Creek.	Middle bench 31 inches . .	Lower bench 17 inches . . .
Moisture	2.20	2.34
Volatile combustible matter	36.56	34.32
Fixed carbon	53.14	56.12
Ash	8.10	7 20
Sulphur	3.645	1.265

This coal seam appears to be more variable in thickness and quality in the Beaver creek region than elsewhere in this conglomerate field.

At the tunnel cut next above Cumberland Falls station, this seam shows 39 inches of coal, with 18 inches above, separated by 8 inches of clay shale. It has also been recently opened at the station nearly down to railroad grade. The four mines mentioned are in Pulaski county. This bed would doubtless be found at its proper outcrop level in the South Fork valley, in Whitley county, 200 feet or more below the grade of the Cincinnati Southern Railroad.



Winding-stair Gap C.

But one opening of this bed has been noted in the Rockcastle region. This is at the Winding-stair Gap, near the mouth of Cane creek, in Laurel county, beyond the limits of the accompanying map. A cut and an analysis is appended for comparison with the preceding:

Moisture	1.80
Volatile combustible matter	36.40
Fixed carbon	56.00
Ash	5 80
Sulphur	1.650

Above this coal level follows a conglomerate sand-rock from 100 to 200 feet in thickness. This is removed in part or entirely over a considerable part of this field. It is most prominent towards the Tennessee line, forming the

rock tables southward from Flat Rock station. Like the whole formation, this upper member of the Rockcastle group decreases in thickness northward. The report on the coals of Jackson county and a part of Rockcastle will give an increased number of beds from the local prominence of the thin coal found here near the top of the Chester group. Portions of Lee, Estill, Wolfe, Powell and Menefee counties are included in this conglomerate coal-field. The number of workable beds in the latter county in this formation is reduced to one. The whole field is one of promise beyond what had been expected of this cliff-forming part of the coal measures.

Of the coals in the corresponding Pine Mountain conglomerate, little is yet known. As the beds here are tilted so as to be unprofitable for mining purposes, it has been thought best not to attempt a study of the coals of this monoclinal mountain until the more important fields have been developed.

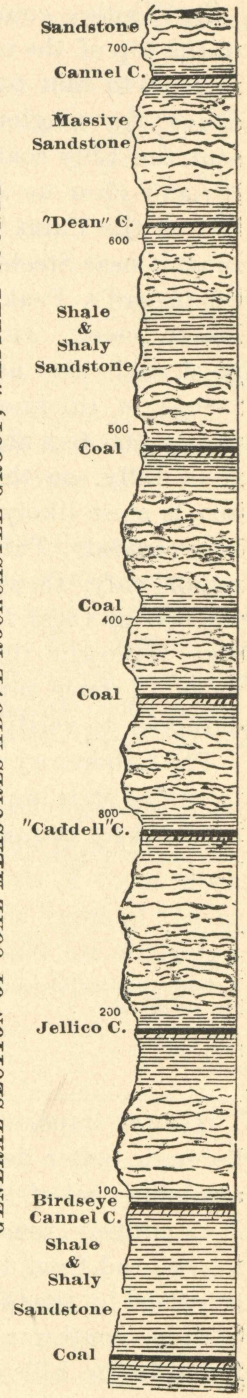
The possibility of finding the Oriskany iron ore in this uplift, although not within the present means of the Survey to determine, gives to this ridge an economic interest which should not be overlooked. The uplift is certainly such as to bring the Oriskany formation above the main drainage. It is, however, covered by the horizontal measures north of the fault-line, or by the *debris* fallen from the steep face of the mountain. The question of the occurrence of this iron ore is one of great importance in connection with the coking coals which have already been developed. From what is known of its occurrence elsewhere, the probability of its being found here is sufficient to warrant the expenditure necessary for a practical solution of the question.

MEASURES ABOVE THE CONGLOMERATE.

The series above the Rockcastle group is made up of alternating shales and sand-rock, the former varying from clay shale and slate to shaly sandstone, the latter from slaty to massive sand-rock. No conglomerate rock has been observed, though the massive sand-rocks are often coarse, giving rise to jagged ledges and cliffs, especially in the middle and upper portions. This series is coal-bearing throughout; though little

is known of the value of the upper coal beds. Iron ore in kidney segregations or in thin beds occur more especially in the lower portion. No limestone is found; but calcareous strata occur, without definite place in the vertical section. In the more shaly lower part of the section calcareous concretions are more or less abundant, bedded in the shale rock, as noted in other parts of the Eastern Kentucky coal field. These concretions are noticeable from their lenticular form, and from their buff or whitish earthy lime composition. They vary from a few pounds weight to masses weighing tons. More rarely this rock occurs in jointed beds. By reference to former reports, it will be seen that these calcareous concretions are associated with Coal No. 1 of the Greenup, Carter and Lawrence region. They are traced along the Kentucky, the Licking and the Big Sandy valleys to the Pound Gap region, where they are associated with the increased number of coal beds in the shaly lower part of the geological section, or in the shales below the Elkhorn coal. In the Whitley region they are in the shales below the Jellico coal. The irregularity of their vertical distribution within the limit of about 200 feet or more, in some portions of the Eastern coal-field, makes this feature an uncertain guide for the identification of equivalent beds, but it is important in a more general comparison of vertical sections.

The place of the first coal above the conglomerate measures is indicated in the preceding general section. It is the equivalent of the Altamont, Pittsburg, Lilly seam of Laurel county.



GENERAL SECTION OF COAL MEASURES ABOVE ROCKCASTLE GROUP, WHITLEY COUNTY.

In Whitley county it has not been opened in such relation to the top of the conglomerate measures as to give it a definite relation to that formation. In Laurel it is from 50 to 75 feet above the conglomerate. The bed which appears to represent the Lilly coal in Whitley has been noted along the Cumberland river as a stain, is opened at Albert Mahan's, at the bed of the Paint branch of Jellico creek, at the mouth of the branch near Steeley's store, at M. E. White's, near the foot of Shepheard's Peak, or Lone mountain, and along the road to Marsh creek, with an average bed section of 30 inches of good coal; also near the head of Marsh creek, Ryan's coal, 36 inches in thickness. All of these exposures appear to be nearly 100 feet above the conglomerate measures. Southward from Lilly, on the tributaries of the Laurel fork, where this bed is most likely to extend in workable thickness, it has not been traced. This coal is above drainage in the Flatwoods region only, though it is not unlikely that the coal shown in the bed of Clear Fork, at various points, up to Saxton station, may represent this seam. Report makes this bed 3 feet or more. I have not been able, from high-water and other hinderances, to verify this account.

The Laboratory report on the Ryan coal gives the following favorable showing. The result of an analysis of the Lilly coal is added for comparison:

	Ryan.	Lilly.
Moisture	2.08	2.00
Volatile combustible matter	35.58	37.00
Fixed carbon	58.90	58.10
Ash	3.44	2.90
Sulphur	.567	1.058

Greater importance will attach to this coal, I think, as it becomes better developed. For local use, it will be the most available coal of the greater portion of the Flatwoods district. It is entirely removed from the Pulaski portion of the Flatwoods, and from that part of Whitley which lies on the ridge traversed by the Cincinnati Southern Railway, north of Whitley Station, southward from Pine Knob Station. This bed may be found in the hills which rise above railway grade.

Several coal seams follow in the upward order to the eastward, in the mostly shaly rocks of the lower part of the general section, which form the low hills towards Jellico mountain, south of the Cumberland river, and towards Watts creek, north of that river. So far as known, they are too thin to have more than a local importance. They are indicated diagramatically in the accompanying generalized section. The coal opened on the land of W. B. Morgan, on the Carr's fork of Watts creek, shows as great a thickness as has been noticed. The bed section here measures 4 feet 3 inches, includiug 15 inches of shale 1 foot from the top.

The yellowish or ocherous shales which form the low hills of a considerable portion of the flatwoods of Whitley, and which are even more prominent in Laurel and Knox counties, and especially noticeable in the Yellow creek valley of Bell, are also the shales of the Clear fork valley, and that of Patterson creek and of Poplar creek, as seen near the base of the hills.

The whole thickness in Whitley is probably about 300 feet. The whole thickness is not exposed at any one point or at different points that have been examined in sufficient detail to warrant a more accurate estimate.

The clay shales of this portion of the general section, especially, less prominently of the whole coal-bearing series, afford valuable deposits of plastic clay. A good illustration of this is found in an excavation along the Procter Coal Company's railway on Indian creek, where a thickness of 8 feet is exposed. A sample cut from 5 feet of the exposed face gives the following result:

	Per cent.
Silica	59.10
Alumina with iron oxide	29.70
Lime carbonate	a trace
Magnesia	.72
Potash	3.86
Soda	a trace
Iron	a trace
Moisture not determin	

This bed is unusually free from impurities excepting potash. Most of these clays are colored more or less with iron. They

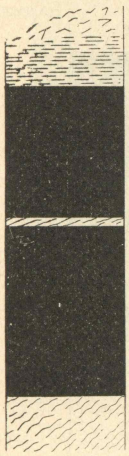
are, however, suitable for the commoner earthen-ware, for drain tile, building tile and terra-cotta, without expensive preparation. What better results may be reached by more careful selection and admixture, remains to be determined by well-directed experiment. In addition to the bedded clays of this portion of the coal measures, the under-clays of the coal seams throughout, ranging from one to four feet in thickness, should be mentioned in this connection. The surface clays of the valleys are very generally suited to brick-making for building purposes.

Of the coals in the measures above the conglomerate division, the bed known as the Jellico seam is the most important. It will, therefore, be first described and made a reference level for the description and identification of other beds. In the series above the Rockcastle group this coal is the third workable bed. Counting all of the coal seams which may have local value, the Jellico seam would be the fourth or fifth in the series.

The Jellico coal is already most favorably known in the market, and the question of its extension and relation to the surface features of the country has a corresponding importance. In its relation to the topography of the hill region to which it is here limited, it ranges from 200 to 400 feet above the main water-courses. In bed section it has a thickness varying from 30 inches to 62, generally separated into two benches by a thin clay parting, which is reduced in its northward extension to a mere trace, or replaced by a thin parting near the base of the bed. In this region this bed is exceptionally persistent in its structural characteristics, as it is also in its composition; being unusually free from excess of ash and sulphur throughout.

Illustrations of bed sections with analyses, covering a large territory, follow. In the first instance, a number of analyses are given of samples taken from the whole bed, from the upper and lower benches separately, and also to show the

difference between a sample from the whole face and a supposed representative lump:



Indian Creek Coal.

SAMPLES TAKEN FROM THE PROCTER MINES.

		Upper Bench		Lower Bench	
	Whole Face.	Whole Face.	Lump.	Whole Face.	Lump.
Moisture	2.00	1.80	2.00	2.60	2.40
Volatile combustible mat.	33.70	35.00	36.40	33 20	33.10
Fixed carbon	61.90	60.60	60.30	62.20	63.10
Ash	2.40	2.60	1.30	2.00	1.40
Sulphur	.796	.714	.714	.769	.494

At the Wooldridge and the Standard mines, a few miles southward in Tennessee, this coal differs in no material respect from that of the Procter mine. The former is 420 feet above the main drainage, and the latter about 20 feet higher.

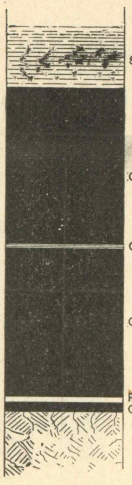
The mine of the East Tennessee Coal Company, in a spur between Jellico and the Main Jellico or Kensee mine, has a bone coal parting of one inch instead of clay. The following is the bed section at this mine, and the result of an analysis of a sample from the whole bed, excluding the bone coal:

Shale roof		Moisture	2.00
Coal	14 inches.	Volatile combustible matter	36.00
Bone coal	1 inch.	Fixed carbon	60.00
Coal	30 inches.	Ash	2.00
Under-clay		Sulphur	.631

The one inch bone coal has 14 per cent. of ash.

The height above Clear Fork is less by 50 feet or more than at the Procter mine, from the eastward dip along the western side of the Clear Fork and Elk creek valley.

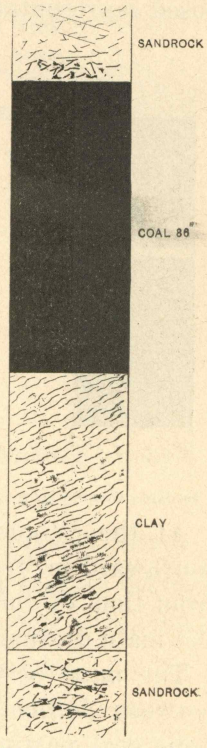
The Main Jellico mine, in a spur of the Jellico Mountain, on Pigeon creek, has an increased per cent. of fixed carbon. Esquire Ridner's opening of the same coal on the Right Fork shows the sandstone roof, which is a characteristic feature northward from this locality.



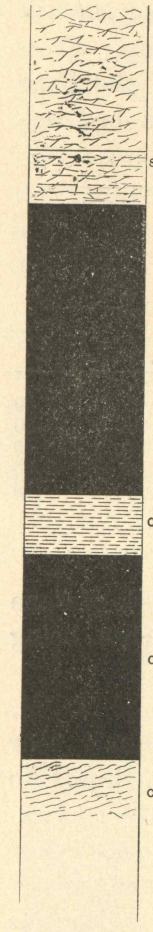
Main Jellico Coal.

Moisture	1.90
Volatile combustible matter	32.86
Fixed carbon	63.10
Ash	2.14
Sulphur	.700

In the Jellico creek region this bed has been opened in several places. Near the old salt well at R. P. Creekmore's, about one mile from the Tennessee line, this bed is considerably thickened, and the clay parting is increased to 7 inches, as in the cut, but the coal is characteristic. Separate analyses are given for the two benches.



Ridner's Coal.

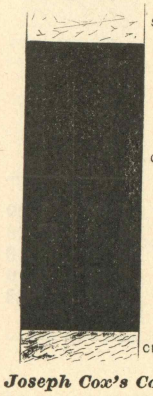


Creekmore's Coal.

	Upper Bench.	Lower Bench.
Moisture	2.00	1.70
Volatile combustible matter	31.30	37.40
Fixed carbon	62.94	59.36
Ash	3 76	1.54
Sulphur	901	1.721
Specific gravity	1.285	1.263

This coal will be found in all of the Jellico creek region south of Pleasant Run, and in the Lone Mountain north of that stream.

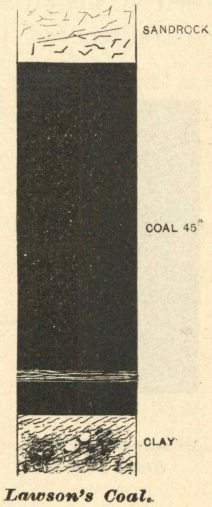
Northward from the mining district, the Jellico coal has been opened at a number of places on Wolf creek. The coal imperfectly opened near Mr. Thomas' house, on the Left Fork, showing 30 inches, probably represents this bed. Other exposures on the main creek, near M. E. Mahan's, about 250 feet above the creek, indicate the place of this bed with less certainty. But on Possum branch this coal is readily identified. It is opened at Joseph Cox's and also at Jas. Cox's, 36 and 39 inches, with traces of a clay seam 15 inches from the top. Here the bed is about 280 feet above the local drainage.



Joseph Cox's Coal.

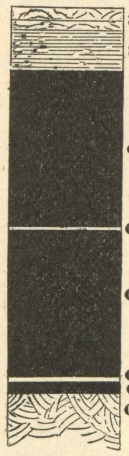
Moisture	1.84
Volatile combustible matter	33.84
Fixed carbon	59.96
Ash	4.36
Sulphur	2.18

The Lawson coal, in the point of the hill nearer to Pleasant View station, is



Lawson's Coal.

thicker, as shown in the cut. On the opposite side of the hill this bed is opened on the land of Robert Bird, Esquire. Freeman's coal, on the north side of the Cane creek valley, is almost identical in bed section.



Bird's Coal.

	Bird's Coal . .	Freeman's Coal.
Moisture	2.40	1.60
Volatile combustible matter	34.80	37.20
Fixed carbon	58.80	58.40
Ash	4.00	2.80
Sulphur	.522	.796

This bed is also exposed on the head of the Left Fork of Cane creek, somewhat reduced in thickness, only 28 inches being shown as opened by Mr. Ridner.

On Brier creek, this seam is opened on the land of Mr. M. Richardson, showing a similar bed section. Openings near the head of the creek indicate a reduction in thickness to 30 inches, as at Mr. Jones' and at Mr. Greer's. (The coal exposed at the latter place may prove to be the seam next below the Jellico bed.) But Foley's coal, recently opened nearer Williamsburg, shows 47 inches, including one inch of bone-coal.

Richardson's Coal, Brier Creek.

	Richardson's Coal . . .	Jones' Coal.	Greer's Coal.
Moisture	1.94	1.90	1.90
Volatile combustible matter	38.92	36.10	37.40
Fixed carbon	56.84	59.50	58.60
Ash	2.36	2.50	2.10
Sulphur	.764	.997	.928

In Jones' Peak, on the Jellico creek side, this bed, as recently opened, shows as follows:

Shale to sand-rock above	2 feet	Moisture	1.76
Coal	39 inches	Volatile combustible matters	37.86
Clay	5 inches	Fixed carbon	53.98
Coal	3 inches	Ash	6.40
Clay	1.5 inches	Sulphur	.607
Coal	7.5 inches		

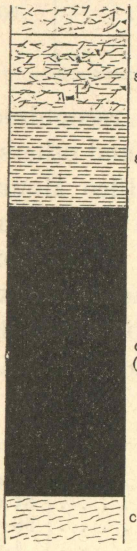
In the Williamsburg region the Jellico seam is recognized from openings made by Dr. Gatliff, Jno. W. Seiler and others, in Morgan Mountain, the river terminus of the Jellico Mountain west of the town. On the west side of the mountain, which is about 900 feet high, an opening made by W. C. Cox also shows this coal in its specific character, 37 inches thick. The average thickness in this locality appears to be about 40 inches. An analysis of a sample from an entry on the land of Mr. Seiler gives the following result:

Moisture	2.00
Volatile combustible matter	34.00
Fixed carbon	58.44
Ash	4.80
Sulphur	1.428

East of the Clear Fork, the Jellico coal has been traced to the Pine Mountain, where it terminates at the fault line in the face of the mountain. In the hills opposite to Pleasant View, this seam is opened at a number of points extending southward to Buck creek, at a height of about 340 feet above Clear Fork, and varying in thickness at outcrop from 37 to 41 inches. On Tackett's creek, the Terril Seiler coal represents this bed. It is 41 inches thick, with one-half inch clay 16 inches from the bottom. The following analysis is of this coal as opened near the head of the creek:

Moisture	2 10
Volatile combustible matter	36 60
Fixed carbon	57.70
Ash	3.30
Sulphur	.708

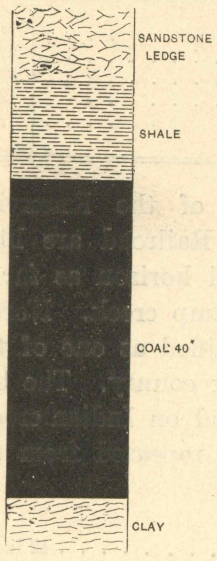
Jones' coal, opened near the head of Little Patterson creek, 100 feet above the bed of the creek, probably represents the Jellico seam, though the structure approaches more nearly to splint than is usual for this bed. The bed section and composition is, however, characteristic.



Jones' C. Little Patterson cr.

Moisture	2.14
Volatile combustible matter	36.06
Fixed carbon	59.20
Ash	2.60
Sulphur	.755

This seam was formerly opened on the main Patterson creek by Messrs. Clapp and Fixton, 115 feet above the Polley coal, which will be described in connection with the Bird's-eye seam. This entry has fallen in so as not to show the thickness of the bed. Coal thrown out shows the characteristic Jellico fracture. The same bed is exposed in a ravine on Rose's Fork of Patterson creek, about 200 feet above the local drainage. On Little Caney creek this bed shows 36 inches. In the ridge between Big Caney and Mud creek, it is opened in a number of places with a minimum of 37 inches without parting. On Mud creek, in the face of Pine Mountain, two and one-half miles above Boston, this seam has been opened by Wymer Seiler, 275 feet above the creek, in the horizontal measures which extend to the fault along the face of the mountain. Slight traces of the clay seam were noted here. which are not shown in the subjoined cut.



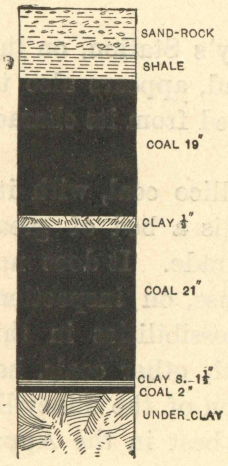
Wymer Seiler's Coal, Mud Creek.

ANALYSIS OF THE WYMER SEILER COAL.

Moisture	2.58
Volatile combustible matter	33.12
Fixed carbon	62.70
Ash	1.60
Sulphur	.670

The coal, 36 inches thick without parting, opposite to Wm. Wilson's house, near the head of Golden's Fork of Poplar creek, may possibly be the Jellico seam, but it is probable that the coal, 80 to 90 feet higher up in the section, opposite to Mr. May's, two miles down the creek, indicates the place of the Jellico coal in this locality. Very little has been done to develop this bed in the Poplar creek region.

North of the Cumberland river the Jellico seam has been opened at a few points only. The coal opened on the land of H. C. King, near Mahan station, is clearly identical in character and surrounding with the Jellico seam south of the river. It is 40 inches thick, and about 280 feet above the bed of the creek. The bed section and analysis are as follows:

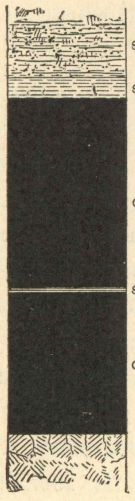


H. C. King's Coal, Near Mahan Station.

Moisture	4.60
Volatile combustible matter	32.80
Fixed carbon	59.00
Ash	3.60
Sulphur	.742

On Brown's creek, 200 feet above the creek, at Mr. Falkner's house, this bed shows as a stain along a bench in the hill.

On Tyree's Fork of Watts creek, two and one-half miles from Rockhold station, this bed has been opened, and an entry driven fifty yards or more. Measurements and collections were made at the heading of the entry.



Moisture	1.80
Volatile combustible matter	37.00
Fixed carbon	57.80
Ash	3.40
Sulphur	.961

The hills on the east of the Knoxville Branch of the L. & N. Railroad are high enough to include this coal horizon as far as the headwaters of Lynn Camp creek. Northeastward it has been identified as one of the economic features of Knox county. The bed section of this coal, as found on Indian creek, near Robert Ford's, is here repeated from the report of Mr. Thruston:

W. T. King's Coal, Tyrees Fk. of Watts Cr.

Coal	42 inches
Parting	4 to 6 inches
Coal	4 inches
Under-clay.	

The North Jellico seam, as mined near Gray's Station, on the Cumberland Branch of the L. & N. Railroad, appears also to be at this level, though not so readily identified from its character and surroundings.

From the preceding description of the Jellico coal, with its regional extension, it will be seen that it is a bed of great importance to the county and to the coal trade. It does not appear to be a coking coal in a special sense, on inspection. Sufficient experimental work to show its possibilities in this direction, either by itself or by mixing with other coals, has not been done. It appears to be at the horizon of the Pineville coking coal, which already ranks with the best in the Appalachian field. The Jellico coal is recognized as a steam and a grate coal of the first rank, and as such it has become the basis of one of the largest coal mining interests in the State. The mining plants in operation here are on a scale suited to a growing industry. The accompanying photo-engraving of the Tip-house of the Procter Coal Mining Company is an illustration of this. This Tip-house is in many respects the perfection of a modern arrangement for handling the output of a coal mine. Its

Tiphouse at Procter Coal Mines, Whitley County, Ky.

Birds-Eye Cannel Coal, Patterson Creek.

capacity, which can readily be doubled by substituting a second basket for the counterpoise weight and adding a second set of screens, is 1,000 tons per day of twelve hours. The capacity of the five mining plants is in excess of the railroad transportation provided, especially to the Southern markets. The increasing demand for this coal makes additional transportation lines a necessity, the meeting of which will add greatly to the industrial wealth of the county.

Below the Jellico seam, 100 to 125 feet, in a portion of the Whitley region, is a bed which will find a ready demand from its free-burning qualities. It is known as the Bird's-eye coal, from the peculiar pitted fracture which it exhibits in unusual perfection.

The accompanying photo-engraving illustrates this, necessarily imperfectly, but better than words could describe it. The face represented is at right-angles to the stratification. In some instances this peculiar fracture is shown in two planes, nearly at right-angles to each other, and to the deposition plane. It is preserved with greater or less distinctness through changes in the character of the coal from a rich, pure cannel to semi-cannel or splint coal, and to a block coal; but it does not generally prevail through the whole thickness of the bed.

The field for this coal is the Patterson creek region and the heads of adjacent creeks, Big and Little Caney, Mud and Poplar creeks. Westward from this district it is a splint coal 20 to 30 inches thick, and is one of the thin coals already mentioned.

The following sections and analyses represent this bed as known from the few openings made to show its range as a workable bed.

Polley's Coal, Patterson Cr

The Polley coal, near the head of Patterson creek, shows the maximum thickness so far as known. The subjoined analysis is of a sample from the whole thickness:

Moisture	2.14
Volatile combustible matter	39.76
Fixed carbon	55.06
Ash	3.04
Sulphur	.892
Specific gravity	1.279

From an opening on head of Little Caney creek, showing 28 inches Bird's-eye cannel coal, and six inches of common bituminous coal resting on it, an average sample of the cannel portion is found to have the following composition:

Moisture	1.00
Volatile combustible matter	43.00
Fixed carb n	48.80
Ash	7.20
Sulphur	1.207

Bennett's Coal, Bennett's Cr

On Bennett's creek, a branch of Patterson, heading against Big Poplar creek, this seam has a thickness of 48 inches of semi-cannel coal, the analysis of which is as follows:

Moisture	2.40
Volatile combustible matter	35.80
Carbon in coke	58.96
Ash	2.84
Sulphur	.555
Specific gravity	1.282

Near the head of Mud creek this bed is a Bird's eye cannel coal, like that on Little Caney. The same is true on the head of Patterson creek, but generally it is a semi-

cannel, scarcely inferior to cannel as a grate coal, and at the same time a steam coal of the highest promise.

The thickness of this bed, as noted at other places in this district, varies from 31 inches on Rose's Fork, to 41 inches on Long Branch, which heads against Tackett's creek of the Clear Fork valley ; and 36 inches at Wilson's, on the Golden Fork of Poplar creek. This last named coal being referred to this horizon somewhat doubtfully, as is also the coal reported on Long Branch of Poplar creek, but not seen. In all this district this seam is near the base of the hills. Out of this district, especially westward, the peculiar structural characteristic of this seam is lost in a great measure ; and the thickness ranges from 20 to 30 inches ; but the quality of the coal still gives it an importance not entirely local, as is shown by the demand for the out-put of the Blevens and Carley and the Meyers mines at Jellico. Its place in the series can readily be traced by its relation to the Jellico coal, which is better known than any of the other coal beds of Whitley, and can generally be made to serve as a geological level from which to start in the identification of beds in the various localities.

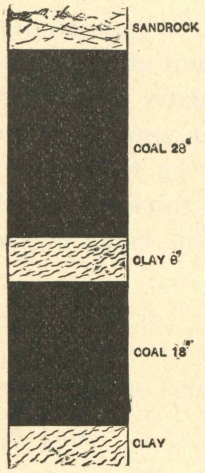
From the showings of coal in the five workable beds already described, the natural wealth of the county will be seen to invite greatly increased industrial enterprises based on these deposits.

There are other notable coal horizons yet to be pointed out. Sufficient development has not been made to admit of any thing like a full description. From 75 to 100 feet above the Jellico seam a bed of considerable importance has been noted at a few points. The Caddell seam, in the ridge between the forks of Wolf creek, which is at this level, shows a thickness of 37 inches. It approaches cannel coal in composition, being a free-burning coal, as indicated by analysis :

Descriptive section.		Moisture	1.50
Coarse sand-rock.		Volatile combustible matter	40 56
Shale and sand-rock	15 feet	Carbon in coke	51.24
Bituminous shale	5 feet	Ash	6.70
Coal	37 inches	Sulphur	2.768
Under-clay.			

On the opposite side of the mountain a parting of bituminous slate separates this seam into two benches. At the head of the Left Fork of Wolf creek, near Aaron Thomas', the "Forked coal" is probably at this geological level. Here the parting is nearly 2 feet, with 18 inches of coal above and 2 feet below, the including rocks being locally a bituminous shale. A coal stain has been observed at a number of points on the Right Fork of Wolf creek at this level. In the Brier creek region only one foot of coal is found in an opening made by Mr. Richardson.

The Mahan Station coal, though generally regarded as the Jellico seam, should, I think, be referred to the next higher, or the Caddell coal horizon. Those who carefully follow the description of Jellico seam in its northward extension will notice its persistent character both in bed section and quality, and also the very great changes in character required to make the Kings coal and the Mahan Station coal equivalent beds. My notes, which I have had no opportunity to correct, make the Kings coal 270 above the railroad grade, and the Mahan Station coal 360 feet above grade. A single set of barometric readings is hardly sufficient to settle this point; but the probabilities are in favor of the views here expressed, though the bed has not been definitely traced in its character as here given, beyond a limited portion of the Whitley field, and is without a recognized equivalent in adjoining counties.



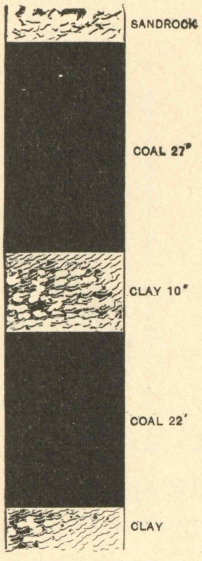
Mahan's Coal, Watts Creek.

The following cut and analyses represent the Mahan Station coal:

	Upper part	Lower part
Moisture	2.20	2.20
Volatile combustible matter	33.10	34.86
Carbon in coke	56.80	58.14
Ash	7.90	4.80
Sulphur	4.234	1.340

Berry's coal along the ridge, 1 mile from the Mahan Station opening, has been more

carefully studied by R. C. B. Thruston, and shows very promising coking qualities, which it may be hoped will be realized by practical tests.



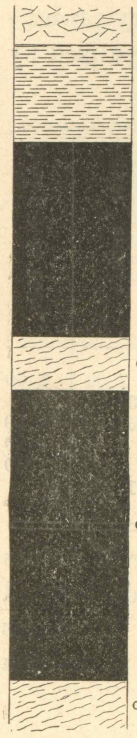
Berry's Coal, Watts' Creek.

	Upper Bench	Lower Bench	Coke (whole bed)
Moisture	2.00	2.00	2.00
Volatile combustible matter	33.40	34.54	. . .
Carbon in coke	61.90	61.92	94.80
Ash	2.70	1.54	3.20
Sulphur	.637	.830	.849
Specific gravity	1.254	1.289	. . .

This coal is opened at a number of points along the ridge for several miles beyond Berry's opening, and probably from its prominence here it will be found to have a considerable areal extension.

Above the Mahan Station or the Berry seam, two thin coals have been noted in the overlying 200 feet or more of sand-rock and shale, as indicated in the general section. The third, though not proven to be a workable bed in thickness, is sufficiently prominent to lead to the expectation that at some points it will be so found.

The next coal above, though too high in the hills to be of immediate value, is interesting as representing the Dean coal of Bell county, in its southward extension into Whitley. See report on Bell county by R. C. B. Thruston and the writer.



Bennett's Coal, Harp's Creek.

It has been opened at a number of places at a vertical distance above the Jellico coal of 450 to 475 feet. Bennett's coal on Harp's creek, a tributary of Poplar creek, represents this seam.

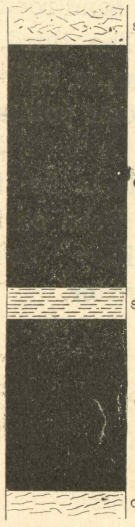
	Upper Bench	Lower Bench
Moisture	2.46	1.60
Volatile combustible matter	34.14	34.00
Fixed carbon in coke	57.80	56.80
Ash	5.60	7.60
Sulphur	.848	.820

The lower bench is largely splint coal. The whole bed has all the appearances of a good coal.

This coal is shown on the Golden Fork of Poplar creek, varying somewhat in the details of the bed, but apparently the same in character. Here the coal was only faced up to show the thickness, and no sample for analysis was collected.

On the head of Mulberry creek this bed is reported as having a similar section.

It is opened in the hill between Tackett's creek and the Clear Fork near Pleasant View, 150 feet below the top of the hill, showing the following section, as faced up without driving to roof-rock:



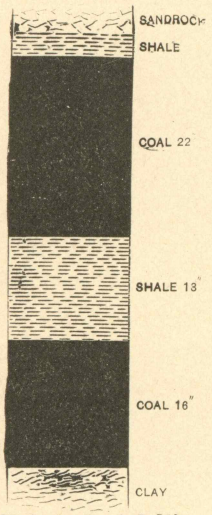
Adams' Coal, Head of Golden Fork.

Earth.	
Coal	13 inches
Clay	1½ inches
Coal	15 inches
Clay	½ inch
Coal	7 inches
Clay	½ inch
Coal	8 inches
Under-clay.	

In the high hill opposite the house of Mr. Jones, near the head of Brier creek, this coal shows two partings :

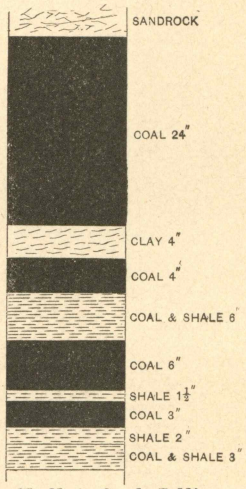
Shale.	
Coal	23 inches
Shale parting	5 inches
Coal	24 inches
Clay shale	14 inches
Coal	12 inches
Under-clay.	

In Shelley's Mountain, at the head of Wolf creek, this bed is rendered nearly valueless by shale partings, though the quality of the coal is good. The bed is shown to be variable in section by the two subjoined cuts, which represent it at two points about one-half mile apart. Analysis of upper part only :



Shelly's Coal, Jellico Mountain.

Moisture	2.24
Volatile combus'le matter.	35.66
Carbon in coke	58.76
Ash	3.34
Sulphur	1.060



Shelly's Coal, Jellico Mountain.

At the head of Caney creek, the coal which appears to be at this horizon has the following section :

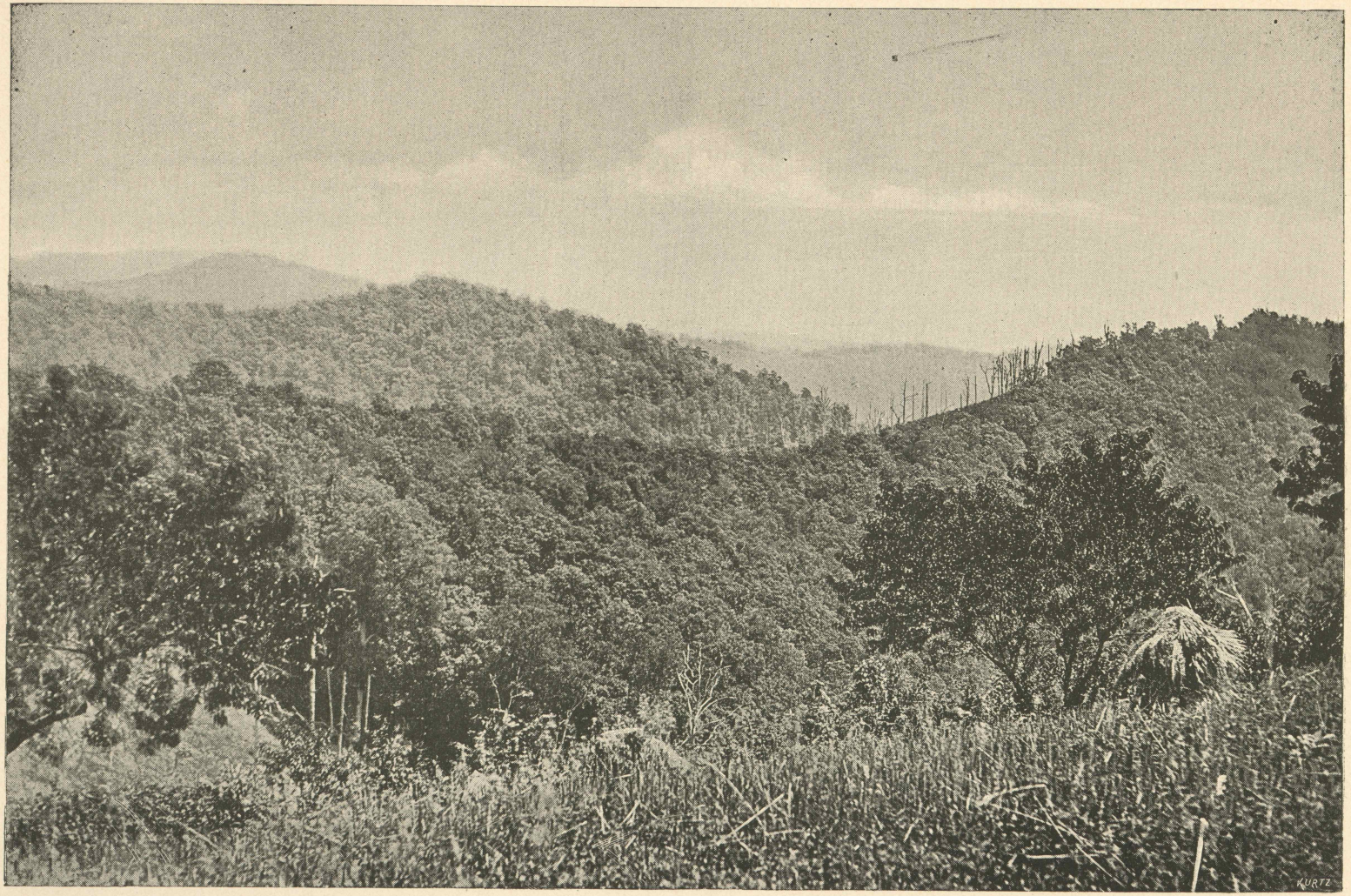
Sandstone roof.	
Coal	30½ inches
Clay shale	3½ inches
Semi-cannel coal	8 inches
Clay shale.	

On Rose's Fork of Patterson creek this bed shows 38 inches of coal, with the bird's-eye fracture in the lower layers.

The cannel coal of the Standard mines near Jellico, in Tennessee, is on the bench next above the Dean coal, something more

than 500 feet above the Jellico coal. Fragments of cannel slate have been noted at this level at a number of points, notably in the ridge between Smith's Branch of Brier creek and Cane creek. At the head of the Left Fork of Wolf creek, a bed 26 inches thick, part cannel, was opened. This is a cannel coal horizon in Bell county, and workable pockets of cannel may very probably be found in the high hills of Whitley.

There are still coal seams above this bed to the tops of the highest hills, but little is yet known of them here. They are important as representatives of the beds of adjoining fields, chiefly. These upper coals will, therefore, be more fully described in a general report of the Eastern Coal Field.



View of Jellico Mountain, Whitley County, Ky., looking eastward.

Peak Mountain and Flatwoods, as seen from Jellico Mountain, Whitley County, Ky.

Flatwoods Region, as seen from Peak Mountain, Whitley County, Ky.

Jellico, Whitley County, Ky., and Campbell County, Tenn.